Soft-Start Circuit for Step-Down Switching Regulator

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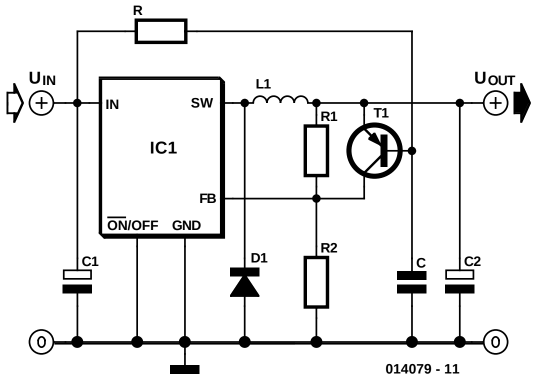

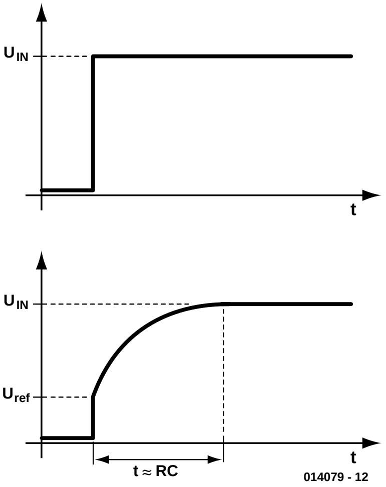

$$U_{out} = U_{ref}\left(1+\frac{R1}{R2}\right)$$

There are very many switching regulator ICs for reducing a dc voltage. In the 'step-down' operating mode, an internal switch connects the input voltage to the charging coil L1. The increasing magnetic field stores energy. When the switch opens, coil L1 attempts to force the current to continue to flow. For this purpose, the flyback diode D1 must be present to allow continued current flow. Output capacitor C1 smoothes the output voltage, while the voltage divider R1/R2 feeds back a portion of the output voltage to the sense input (FB) of the IC. The predefined internal reference voltage U_{ref} causes the indicated output voltage to be achieved. One limitation is that the output voltage must be less than the input voltage (step-down principle). The reference voltage usually lies at 1.2 V.

If it is necessary to have the output voltage rise slowly after the power has been switched on, the circuit trick shown here can be used. Transistor T1 initially shorts out the upper resistor of the output voltage divider, since capacitor C is at first uncharged. This means that the output voltage is equal to the reference voltage. Capacitor C is slowly charged by the current passing through R, which is connected to the input voltage. Transistor T1 thus conducts increasingly less, so the voltage divider R1/R2 slowly becomes effective. Once the voltage across C is greater than the output voltage, the base-emitter junction of T1 is reverse biased and the transistor remains completely cut off.

Attention should be given to the base-emitter breakdown voltage of the transistor selected for T1. The difference between the input voltage and the output voltage must not exceed this limit.

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